CALIFORNIA DEPARTMENT OF TRANSPORTATION

GEOTECHNICAL DESIGN REPORT

Construct Highway from State Route 98 North to Interstate 8
In the County of Imperial 10.5 kilometers East of Calexico

11-IMP-7, KM 1.9/10.9
11-068001

Prepared for:

Caltrans
District 11

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1. INTRODUCTION

This report addresses geotechnical design considerations for the proposed project to extend existing State Route 7 in Imperial County north to Interstate 8 from its present northern terminus at SR-98 (Figure 1). The project will construct the final segment of SR-7 needed to connect the new international border crossing to Interstate 8. Once completed, the route will serve the Port of Entry at the US/Mexico border that is expected to handle a high volume of commercial truck traffic anticipated to be greater than 19,000 vehicles per day.

Major project features include nine kilometers of divided 4 lane expressway, the Hunt Road Overcrossing, the South Alamo Canal Bridge, and reconfiguration of the I-8 Interchange.

The geotechnical investigation consisted of site reconnaissance, research of existing reports and archived resources, exploratory soil borings, laboratory testing, cone penetration testing, data evaluation, and analysis.

The purpose of this report is to document subsurface geotechnical conditions, provide analyses of anticipated site conditions as they pertain to the project described herein, and to recommend design and construction criteria for the roadway portion of the project. This report also establishes a geotechnical baseline to be used in assessing the existence and scope of changed site conditions.

This report is intended for use by the project roadway design engineer, construction personnel, bidders, and contractors.

2. EXISTING FACILITIES AND PROPOSED IMPROVEMENTS

The proposed alignment will traverse terrain that includes cultivated fields, dirt fields, dirt access roads, drainage ditches, irrigation ditches, county roads, and the South Alamo Canal (Figure 2).

The proposed expressway will consist of a roadbed up to 50 meters wide bordered by broad v-ditches (Figure 3). The roadway, comprised of a broad median with two northbound and two southbound lanes, will be slightly elevated above the native terrain. Typically, the roadway will be elevated less than two meters.

A bridge will be constructed over the South Alamo Canal. An overcrossing is planned at Hunt Road. Loop ramps and improved connector ramps are planned for the SR-7/I-8 Interchange. Relatively thick embankment fills will be constructed at these locations.

At-grade intersections are proposed for Heber Road and McCabe Road. Cul-de-sacs are proposed where the route alignment bisects King Road.

Soundwalls are proposed at two private residences adjacent to the SR-7 alignment at King Road.

Numerous private drainage crossings and irrigation siphons will be constructed to continue water conveyance across the route alignment.

Two retention/detention basins will be constructed. The elongated basins will be constructed between SR-7 and the Alamo River at Stations 38+00 and 66+30.

3. PERTINENT REPORTS AND INVESTIGATIONS

Preliminary Geotechnical Report; 11-IMP-7, K.P. 1.9/10.8, 11-068000. May 15, 1997. Prepared by Joseph P. Egan

Geotechnical Design Report; 11-IMP-7, P.M. 0.0/1.2, 11-092411. In Imperial County, near Calexico, from the International Border to State Route 98. February 1994. Prepared by District 11 Geotechnical Section.

Project Study Report; 11-IMP-7, K.P. 1.9/10.8, Prepared by Caltrans District 11 Design Office.

4. PHYSICAL SETTING

4.1 Climate

The climate in the Imperial Valley is extremely arid. The mean annual rainfall in the City of Imperial, approximately 27 kilometers from the Mexican border, is 75 mm and the mean annual temperature is 23° C. During the months of May through October, the average maximum day time temperature exceeds 38°C.

4.2 Topography and Drainage

The Imperial Valley is a broad, flat lying expanse with little topographic relief. Farm fields in the project vicinity have an extremely mild eastward slope. Surface drainage along the proposed route is from west to east by way of earthen agricultural drainage ditches. The drainage ditches discharge into the Alamo River, which meanders northward just east of the route alignment (see Figures 1 and 2). The Alamo River eventually empties into the Salton Sea, which lies 75 meters below sea level.

The proposed route will traverse existing terrain that is virtually flat. At the southern end of the project, near SR-98, the existing ground elevation is roughly 9 meters above mean sea level (MSL). At the South Alamo Canal Bridge, the existing ground elevation is roughly 11 meters MSL. At the north end of the project, near Interstate 8, the existing terrain is about 5 meters MSL.

4.3 Man-Made and Natural Features of Engineering and Construction Significance

The SR-7 roadway will traverse currently or formerly cultivated agricultural fields. West to east aligned water supply canals and drainage channels service these fields. The water supply canals are typically one to two meters across, concrete lined, and constructed on the embankment of dirt service roads elevated about 1.5 meters above the adjacent farmlands. The drainage channels are depressed roughly 1.5 meters below the field elevation. Where drainage channels do not occur, subsurface field drainage is accomplished through buried collector pipes. Between SR-98 and Heber Road, either a farm road, water supply canal, or drainage channel crosses the highway alignment at semi regular intervals of about 400 meters.

From Heber Road north, the SR-7 alignment crosses four county roads and runs roughly parallel to, or over, two others. Water supply canals cross the alignment infrequently north of Heber Road. However, several private irrigation laterals and Imperial Irrigation District laterals will be impacted due to the roadway alignment and the configurations of the planned intersections.

4.4 Regional Geology and Seismicity

The Imperial Valley lies astride the present axis of a great linear depression that extends nearly 1400 kilometers through Southern California and Mexico to the south end of the Gulf of California. The northern part of this linear depression, commonly referred to as the Salton Trough, is an extension of the Gulf of California physiographic province that has been isolated from the gulf by build-up of the deltaic cone of the Colorado River. The Salton Trough was transformed into a sub-sea-level desert basin probably during the late pliestocene (1 million years before present) when the river delta stood sufficiently high to restrict the influx of sea water from the gulf to the south. During Holocene time (beginning 10,000 years before present), this basin was periodically inundated by floodwater of the Colorado River to create former Lake Cahuilla, an ephemeral freshwater body whose highest level at times stood slightly above sea level. The latest flooding created the present day Salton Sea in 1905 when the entire flow of the Colorado River was uncontrollably diverted into an irrigation canal.

The geologic structure of the Imperial Valley is that of a deep (10 to 16 kilometers) basin of sedimentary and meta sedimentary rocks whose configuration tends to be an exaggerated version of the present day topography in the Salton Trough.

The stratigraphy of the valley sediments represents a continuous deposition of continental clastic and marine sediments from Pliestocene time to the present. Clay, silt, and sand comprise the most recent and upper portion of the flat lying strata in the project area. These soils are typically unconsolidated. High groundwater is common in the valley.

The Imperial Valley is the most seismically active area in the contiguous United States. The central portion of the valley is a spreading center along the major San Andreas Rift. The rift is comprised of numerous faults that produce relatively frequent and damaging earthquakes. Recent fault breaks and ground displacement in and around the project area have occurred in 1940 and 1979 along traces of the Imperial Fault.

The Imperial Fault crosses the proposed route alignment at about Station 39+30 and trends in a northwest-southeast direction (Figure 1), crossing Interstate 8 2.4 kilometers east of the Bowker Road Interchange. During the 1940 and 1979 earthquakes, severe ground shaking, surface faulting, and liquefaction occurred in the project area.

5. EXPLORATION

A subsurface exploration program was conducted in order to document and evaluate soil conditions along the route alignment. The exploration program was conducted in February and March 2000. The program consisted of a combination of exploratory soil borings and cone penetration testing. Test point locations are displayed on Figure 2.

5.1 Drilling and Sampling

Exploratory soil borings were conducted during the period from February 28 through March 3, 2000. A total of 8 soil borings were conducted for the subsurface investigation. The Soils and Geologic Exploration Logs are contained in Appendix A. The soil borings were advanced into the ground using a Mobile B-47 drill rig and bentonite mud rotary drilling. Standard Penetration tests were conducted at intervals of 1.5 meters. Based on CPT data, relatively undisturbed 50 mm brass lined California samples were collected at several borings for laboratory testing. SPT test results and soil sample depths are indicated on the boring logs. The soil borings along the alignment were drilled to depths between 11 and 15.5 meters below the existing ground surface. The deeper borings coincided with locations of large proposed embankment fills such as at the Hunt Road Overcrossing and at the SR-7/I-8 Interchange.

Piezometers were installed in several bore holes. The piezometers were screened at discreet intervals in an effort to gather relevant information concerning the local groundwater conditions.

Soil classifications in the attached Soils and Geologic Exploration Logs follow the guidelines of the Caltrans Office of Structural Foundations Soil and Rock Classification Manual which is generally based on the Engineering Geology Field Manual published by the Bureau of Reclamation.

6. GEOTECHNICAL TESTING

A geotechnical testing program was developed in coordination with the subsurface exploration program. The testing program was designed to reveal the physical and engineering properties of the native soils as they pertain to the proposed construction.

6.1 In-Situ Testing

In–situ testing included Standard Penetration Tests (SPT), and Cone Penetration Tests (CPT). These test were used to determine the consistency of the subsurface soils, and to provide data for the settlement and liquefaction analysis. SPT data is shown on the Soils and Geologic Exploration Logs contained in Appendix A. CPT test data are contained in Appendix B.

6.2 Laboratory Testing

Laboratory tests were performed on selected soil samples obtained from the exploratory borings. All samples were tested in the Caltrans Engineering Service Center Laboratory in Sacramento. Laboratory tests were conducted in accordance with the California Test Method (CTM), the American Society for Testing and Materials (ASTM), or the American Association of State Highway Testing Officials (AASHTO).

The laboratory tests performed included unit weight, moisture content, Atterberg Limit tests, sieve and mechanical analysis, and consolidation tests. The laboratory test results are contained in Appendix C of this report.

7. GEOTECHNICAL CONDITIONS

7.1 Subsurface Soil Conditions and Site Geology

Seismic refraction and well data collected for previous studies in the Salton Trough sedimentary basin suggest that the depth to basement rock is over 3.5 kilometers in the project area.

The near surface soils generally consist of horizontally bedded clays, silty clays, and fine to medium grained sand with varying amounts of silt. The clays are usually firm to very stiff and medium plastic to very plastic. The clayey silts are stiff to very stiff and exhibit low to medium plasticity. The sands are medium dense to dense. Due to agricultural practices, the upper one meter of the existing soil is generally loose/soft in consistency. Previous investigations in the project area have determined that the agricultural top soil has an average relative compaction of 82 %.

The near surface soils vary along the route alignment. South of Station 90+00 near McCabe Road, prominent layers of sand and silty sand comprise a major portion of the site stratigraphy. North of Station 90+00, thick beds of clay and silty clay dominate the stratigraphy with the occurrence of sand and silty sand diminishing to sparse beds less than one meter thick. These thick clay deposits underlie important project features such as the Hunt Road Overcrossing and the SR-7/I-8 Interchange.

7.2 WATER

7.2.1 Surface Water

The highway project does not encompass any natural bodies of surface water. Surface water occurs within the project area in man-made farm irrigation supply and drainage canals. The necessary relocations and modifications to some of the canals will not significantly alter the occurrence or pattern of flow of surface water. Scour and erosion problems are not applicable to the project.

At the SR-7/SR 98 Intersection, the Alamo River is located less than 0.5 kilometers to the east. Travelling north, the Alamo River diverges to the east of the SR-7 alignment (see Figure 1). The water within the Alamo River is derived primarily from irrigation drainage with some contribution from urban runoff and occasional storm water influx. During the field investigation conducted for this report, water in the Alamo River occurred as discontinuous ponds with no observed surface flow. Flooding on the Alamo River has occurred in association with tropical storms as recently as August, 1977.

Two retention/detention basins are planned to detain storm water runoff from the roadway. The elongated basins will be constructed in an east-west orientation between SR-7 and the Alamo River at Stations 38+00 and 66+30 (see Figure 2). The basins will reduce peak flow of storm water runoff into the Alamo River during storm events. The basins will also act to improve the water quality of the highway runoff. Short or long term storage of water within the basins should have no adverse effect on the highway embankments or the surrounding agricultural fields.

7.2.2 Groundwater

Locally perched groundwater was found in all of the exploratory soil borings at an elevation ranging between 1.6 and 3.0 meters below the ground surface. The groundwater level at the time of the investigation is displayed on the boring logs. This groundwater is perched on low permeability clay layers and primarily results from local farm irrigation and possible canal leakage. The perched water levels can be expected to vary slightly depending on the season and nearby irrigation practices. However, the perched groundwater surface roughly coincides with the level of the drainage tiles underlying the farm fields and therefore remains relatively constant. The high salt content and contamination of the groundwater is a result of the local farming practices.

Although inconclusive, piezometer readings suggest there may exist a slight difference between the perched water levels and the regional or phreatic water table. The difference in water table elevations is not significant to this project. The elevation of the phreatic water table likely coincides closely with the water elevation in the adjacent Alamo River. The regional water table can be expected to remain relatively constant over time.

The highway facility will alter a very small percentage of the local land use. A minor loss in surface water infiltration will occur due to the paved roadway surface. Minor additional surface water infiltration will occur at the retention/detention basins. The proposed project includes no need or plans for dewatering. The project will result in no significant impact on the existing groundwater conditions.

7.3 Project Site Seismicity

7.3.1 Ground Motion

Several major faults have the potential to impact the project area, but none more so than the Imperial Fault. The Imperial Fault crosses the proposed route alignment at about Station 39+30 and trends in a northwest-southeast direction (Figure 1), crossing I-8 2.4 kilometers east of the Bowker Road Interchange. During the 1979 Imperial Valley Earthquake, severe ground shaking and minor liquefaction occurred in the project vicinity. Surface faulting produced by the earthquake extended from about 5 kilometers south of Brawley to the Heber Dunes. During the 1940 earthquake, ground rupture on the Imperial Fault crossed the proposed SR-7 alignment.

A record search of historic earthquake and fault data was conducted for this study. The bulk of the data was compiled using the programs EQSEARCH and EQFAULT. The data were developed for a 100 kilometer radius from a point source reference. The reference point was selected to include the entire study area. Additional data were obtained from the Caltrans Seismic Hazard Map (Mualchin, 1996). The compiled data is contained in Appendix D. The design ground motion parameters are summarized in Section 8.1.

7.3.2 Ground Rupture and Shaking

It is impossible to predict the actual location of future ground surface rupture. However, ground rupture and right lateral ground displacement combined with vertical displacement can be expected to occur along the Imperial Fault. Caltrans RGES staff members have observed the displacements from previous seismic events on the Imperial Fault and other faults within the Imperial Valley. The maximum credible earthquake event of magnitude 7.0 on the Imperial Fault could cause estimated lateral displacement along the fault of roughly two meters and vertical displacement across the fault of nearly one meter.

No surface indication of the actual trace of the Imperial Valley Fault crossing the proposed route alignment was evident in the project area during this investigation. It is very likely that any preexisting surface evidence has been obliterated by the local agricultural practices. Historic ground rupture in the Imperial Valley has been well documented in the literature. By comparing archived data to the project plans, the main Imperial Valley Fault trace appears to cross the highway alignment near station 39+30 trending in a northwest-southeast direction.

The main fault trace is not coincident with any significant project feature such as bridges or high embankments. The South Alamo Canal Bridge will be located about 1.7 kilometers from the nearest point on the fault while the Hunt Road Overcrossing will be located about 4.3 kilometers from the fault. Potential offset along the fault is likely to have a limited impact on the highway facility.

Seismic shaking as the result of fault rupture has a greater potential to result in damage to the highway facility. Seismic shaking has produced ground failures on flatlands in the project area. These failures include lateral spreading and ground settlement caused by liquefaction or compaction of the loose sandy deposits beneath the ground surface.

8. GEOTECHNICAL ANALYSIS AND DESIGN

8.1 Dynamic Analysis

The design ground motion parameters recommended for the project and used for further analysis are summarized below:

Controlling Fault:	Imperial Valley Fault
Maximum Credible Event Magnitude:	7.0
Maximum Probable Event Magnitude:	7.0
Peak Horizontal Ground Acceleration:	0.54g (EQFault)
Peak Horizontal Ground Acceleration:	0.60g (Mualchin)
Repeatable Horizontal Ground Acceleration:	0.35g (EQFault)
Probability of Maximum Event:	0.012/year

8.1.1 Liquefaction Analysis

Liquefaction is a phenomenon that occurs in loose, saturated sandy soils that are subjected to seismic shaking. During an earthquake these soils tend to lose strength and become fluid. The consequent soil movement can result in significant settlement of the roadway and related structures. The liquefaction potential of the soils is directly related to the size and duration of the seismic event, the depth to groundwater, the soil type, and the in-place density of the soils.

As mentioned in Section 7.1, the near surface soils vary significantly along the route alignment. North of Station 90+00 near McCabe Road, thick beds of clay and silty clay dominate the stratigraphy with the occurrence of sand and silty sand limited to sparse beds less than one meter thick. These thick clay deposits underlay the Hunt Road Overcrossing and the SR-7/I-8 Interchange. Since the cohesive silty and clayey soils underlying the alignment are not susceptible to liquefaction, the potential for damage to highway facilities due to liquefaction is considered to be very low north of Station 90+00.

South of McCabe Road, prominent layers of sand and silty sand comprise a major portion of the site stratigraphy. An evaluation of the liquefaction potential based on procedures outlined by Robertson and Fear was conducted. The evaluation utilized both CPT and SPT data. The results of the analysis are displayed in Figures 4 and 5. Examination of the figures reveals a low to moderate potential for liquefaction of the sandy soils underlying the roadway and bridge approach fill areas. However, these sandy soils are relatively thin, dispersed, and interbedded with cohesive silty and clayey soils. Accordingly, the overall potential for significant settlement and lateral spreading associated with liquefaction should be considered as low. Spread sheets for liquefaction calculations are contained in Appendix E.

Placement of the roadway embankment fills will cause some densification of the underlying native soils and result in some reduced liquefaction potential. Extreme measures to reduce the potential for liquefaction such as deep dynamic compaction and vibro compaction are unwarranted in light of the high costs associated with such mitigation measures and the limited anticipated impact of earthquake induced settlement. If liquefaction were to occur, it may cause the overlying roadway fills to crack and settle along some portions of the alignment. Delays resulting from roadway distress may be intolerable under certain conditions. These conditions include the lack of alternate routes to highly important facilities such as hospitals, schools, fire and police stations, or special housing. The SR-7 project does not serve any facilities having such a high premium on continuous access. Additionally, alternate north-south routes exist in the project area. In view of these factors, rebuilding the damaged portions of the roadway following a seismic event would be more economical than attempting to mitigate the potential for liquefaction.

8.1.2 Earthquake Induced Settlement

Due to the lack of significant sand layers, earthquake induced settlement is not expected to be significant north of Station 90+00. The relatively tall embankments at the Hunt Road Overcrossing and the SR-7/I-8 Interchange should remain largely unaffected by seismic events.

Earthquake induced settlement of the sands underlying the roadway south of Station 90+00 was estimated using procedures presented by Tokimatsu and Seed (1989). The results of the settlement evaluation are presented in Table 1. The analysis predicts a range of potential earthquake induced settlement from 3 to 78 mm. This estimate is supported by analysis included in previous studies and visual observations following earthquakes in the project area.

The above estimated total settlement is not expected to result in catastrophic failures of the pavement. Any distress resulting from earthquake induced settlement should be of limited degree and therefore repairable within a reasonable period of time.

8.2 Cuts and Excavations

8.2.1 Stability

The topography along the proposed alignment is relatively flat. No major cuts or excavations are planned. Accordingly, no evaluation of cut slope stability was performed for this study.

Minor excavations will occur at the retention/detention basins. All embankment slopes should be constructed at an inclination no greater than 1:2 (vertical to horizontal).

Soundwalls are proposed at two private residences adjacent to the SR-7 alignment at King Road. CIDH pile foundations are recommended for the proposed soundwalls. Overhead signs, if included in the project, will also incorporate CIDH pile foundations. The presence of loose sands and perched groundwater will tend to cause caving of drilled holes during pile construction. To prevent caving of drilled holes, it will be necessary to incorporate methods of wall support during foundation construction. Wall support techniques include the use of bentonite drilling mud or steel casing in the drilled holes. Example Special Provisions are included in Appendix F for use in project preparation.

8.2.2 Rippability

As described in the previous subsection, no major excavations are proposed for the project. It is anticipated that any minor cuts associated with site grading can be easily accomplished using conventional grading equipment.

8.2.3 Grading Factor

The majority of material used to construct the roadway embankment will be imported borrow. No borrow sites have been designated for this project.

A minor portion of the roadway embankment may be generated on-site through excavation of v-ditches and reworking of the soft surface soils. The average relative compaction of the native soils within the upper one meter of the existing ground surface is 82 percent. A grading factor of 0.9 is recommended for roadway embankment derived from the on-site soils. Additionally, it is anticipated that about 50 mm of settlement will occur due to compression of these soft soils during subgrade preparation.

8.3 Embankments

The preliminary project plans indicate that the typical maximum embankment fill height along most of the alignment will be one to two meters with side slopes inclined at 1:2 (vertical to horizontal) or flatter. At the South Alamo Canal the embankment fill height will reach 3 meters. At the Hunt Road Overcrossing the embankment fill height will range from 2 to 8 meters. At the SR-7/I-8 Interchange, embankment fill heights will range from 2 to 6 meters.

No major cuts are proposed for the project. Accordingly, the majority of embankment fill will be imported from off-site sources. The placement and compaction of the embankment fill should conform with Sections 19-5 and 19-6 of the Caltrans Standard Specifications.

All embankment slopes should be constructed at an inclination no greater than 1:2. In view of the probable granular nature of the imported fill soil, slope erosion could occur if the fill slopes are left unprotected. Embankment slopes should be protected from erosion in accordance with Section 20 of the Caltrans Standard Specifications. In addition, the embankment slopes should be planted with deep rooted, drought tolerant trees and shrubs to protect against erosion and to maintain surficial stability.

8.3.1 Embankment Foundations

The proposed roadway embankments will be supported on unconsolidated sand, silt, and clay soils. Under embankment fill loads, the non-plastic silts and sands will undergo instantaneous settlement whereas the clayey soils with low to high plasticity will be subject to time dependant consolidation.

The anticipated settlement under the proposed embankment fills was estimated using consolidation test data and by Sanglerat's Method which utilizes cone penetrometer test data. Settlement of the native soil may be summarized as follows:

Location	Maximum Fill Ht.	Est. Max. Settlement
Typical Section	1 to 2 m	50 mm
S. Alamo Canal	3 m	50 mm
Hunt Rd. O.C.	9 m	250 mm
SR-7/I-8 Interchange	6 m	170 mm

The predicted settlement for each of the preceding locations may be more precisely displayed as a function of fill height as in Figure 6. Figure 6 presents a summary of settlement calculations contained in Appendix G,

Consolidation test results were used to estimate the time to reach 90% settlement of the embankment foundation soils following embankment construction. The analysis predicts that at the South Alamo Canal 90% of long term settlement should occur within two months after fill placement. At the Hunt Road Overcrossing and the SR-7/I-8 Interchange, 90% of long term settlement should occur within 10 months after fill placement. The calculations for time rate of consolidation are contained in Appendix H.

A total of three settlement platforms should be installed during construction to determine when 90 percent of the total predicted settlement has occurred. One settlement platform should be placed at each of the Hunt Road Overcrossing approach and departure fills. At the SR-7/I-8 Interchange, one settlement platform should be placed near "WS"

Line Station 779+60. The precise locations should be determined in the field to coincide with points of near maximum fill thickness and to avoid construction conflicts.

The settlement platforms should be monitored at least twice weekly during placement of the fills. After completion of the embankment fills, monitoring should be performed weekly. The monitoring program may be revised based on actual conditions observed in the field.

No slope stability calculations were performed for this report. If embankment slope ratios are designed to exceed 1:2 vertical to horizontal, or retaining walls are added to the project, geotextile soil reinforcement and slope stability calculations may become necessary.

8.3.2 Embankment Foundation Mitigation

As reported in Section 7.1, the upper one meter of the existing soils along much of the roadway alignment are soft to loose in consistency due to farming operations. In order to provide a suitable embankment foundation, a minimum of 0.7 meters of the existing soft/loose soils shall be removed from beneath the roadbed prism. The remaining 0.3 meters of soft/loose soil shall be scarified, moisture conditioned, and compacted to 90 percent relative compaction. The removed soil may be replaced as compacted fill in accordance with Section 19-5 of the Caltrans Standard Specifications.

8.4 Earth Retaining Systems

No earth retaining systems are planned for the project.

8.5 Soundwalls

Soundwalls are proposed at two private residences adjacent to the SR-7 alignment at King Road. Due to the pervasiveness of near surface soft soils, the potential for seismic shaking, and the occasional high winds impacting the project area, cast-in-drilled-hole (CIDH) pile soundwall foundations are recommended. Design and construction of the soundwalls shall conform to the Caltrans Standard Bridge Detail Sheets. Wall support for CIDH pile foundation excavation is discussed in Subsection 8.2.1.

8.6 Culvert Foundations

No large culverts are proposed for the project. Except for the loose, uncompacted upper one meter of farm field soils, foundation soils are medium dense or denser and should provide adequate bearing capacity with tolerable differential settlements. Culverts to be placed within the upper one meter of the original ground surface need to have the surrounding soil removed and recompacted as described in Section 8.3.2.

Culverts placed beneath roadway embankments will settle along with the foundation soil. The anticipated settlements are given in Section 8.3.1. Culverts subject to excessive settlement may experience changes in the culvert flow line, joint separation, and distress. Drainage design for the project should include consideration of the estimated settlements.

8.7 Corrosion Potential

Laboratory soil tests for corrosion potential were not conducted specifically for this investigation. Due to the local agricultural practices, farm fields in the Imperial Valley generally have highly corrosive soils. The Caltrans District 11 Materials Laboratory has supplied the following soil parameters from which to determine corrosion potential:

pH = 9.1
Minimum Resistivity = 279 ohm.cm
Sulfates = 930 mg/kg
Chlorides = 1980 mg/kg

The following concrete mix design is suitable to provide a 50-year design life for reinforced concrete structures with direct soil contact:

Cement Type: Type II Modified or Type V
Minimum Cement Content: 313.5 kg/m^3
Mineral Admixture Replacement (normally fly-ash): 33%
Maximum Water to Cementitious Material Ratio: 0.40
Minimum Cover Over Reinforcing Steel: 64 mm

The Caltrans District 11 Materials Laboratory will supply complete corrosion analysis and recommendations for the project based on the results of their study.

9.0 MATERIAL SOURCES

Import borrow will be required for embankment construction on the SR-7 project. Caltrans Project Development staff have no plans to designate potential borrow sites. Any imported borrow shall conform to Section 19-7 "Borrow Excavation" of the Caltrans Standard Specifications.

10.0 CONSTRUCTION CONSIDERATIONS

10.1 Construction Advisories and Construction Considerations that Influence Design/Specifications

The upper one-meter of agricultural soil is soft/loose in consistency. Within the roadbed area, this soil shall be removed and recompacted.

Perched groundwater will likely be encountered in any excavation extending 1.5 meters or more below the existing ground surface.

Drilled shafts for foundations may experience caving due to the presence of loose sands and groundwater. Sample Special Provisions for construction under caving conditions have been included in Appendix F

Settlement of the foundation soils will occur due to placement of roadway embankments. The estimated maximum settlement at key locations is as follows:

Location	Settlement
S. Alamo Canal	50 mm
Hunt Rd. O.C.	250 mm
SR-7/I-8 Interchange	170 mm

At the South Alamo Canal 90% of long term settlement should occur within two months after fill placement. At the Hunt Road Overcrossing and the SR-7/I-8 Interchange, 90% of long term settlement should occur within 10 months after fill placement.

The effect of anticipated settlements on existing or proposed facilities should be considered in the design and construction process.

Relatively corrosive soils are pervasive throughout the project limits. Material selection and reinforced concrete design should be conducted accordingly.

10.2 Construction Monitoring and Instrumentation

A total of three settlement platforms should be installed during construction to determine when 90 percent of the total predicted settlement has occurred. One settlement platform should be placed at each of the Hunt Road Overcrossing approach and departure fills. At the SR-7/I-8 Interchange, one settlement platform should be placed near "WS" Line Station 779+60. The precise locations should be determined in the field to coincide with points of near maximum fill thickness and to avoid construction conflicts.

The settlement platforms should be monitored at least twice weekly during placement of the fills. After completion of the embankment fills, monitoring should be performed weekly. The monitoring program may be revised based on actual conditions observed in the field.

10.3 Hazardous Waste Considerations

An Initial Site Assessment (ISA) for hazardous waste was completed in October 1993. The ISA resulted in a finding of no anticipated hazardous waste involvement for the Orchard Road Alternative. No potential hazardous waste sites were identified during the course of this investigation.

10.4 Differing Site Conditions

The conditions described in this report are based on our field exploration, site reconnaissance, research of existing reports and archived resources, interpolation between test locations, geologic analysis, and geotechnical analysis. If field conditions encountered during construction appear to differ significantly from those described in this report, the Office of Roadway Geotechnical Engineering should be notified immediately so that the impact of such conditions can be assessed and revised recommendations may be provided if warranted.